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**Lampert et al.**

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(54) **ELECTRICAL CONNECTOR ASSEMBLY**

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(51) **Int. Cl.**

| | |
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| ***H01R 25/00*** | (2006.01) |
| ***H01R 13/187*** | (2006.01) |
| ***H01R 13/26*** | (2006.01) |
| ***H01R 13/64*** | (2006.01) |
| ***H01R 13/642*** | (2006.01) |
| *H01R 13/41* | (2006.01) |
| *H01R 13/46* | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***H01R 13/187*** (2013.01); ***H01R 13/26*** (2013.01); ***H01R 13/64*** (2013.01); ***H01R 13/642*** (2013.01); *H01R 13/41* (2013.01); *H01R 13/465* (2013.01)

(58) **Field of Classification Search**

USPC ..... 439/679, 691, 693, 680, 282, 296, 284

See application file for complete search history.

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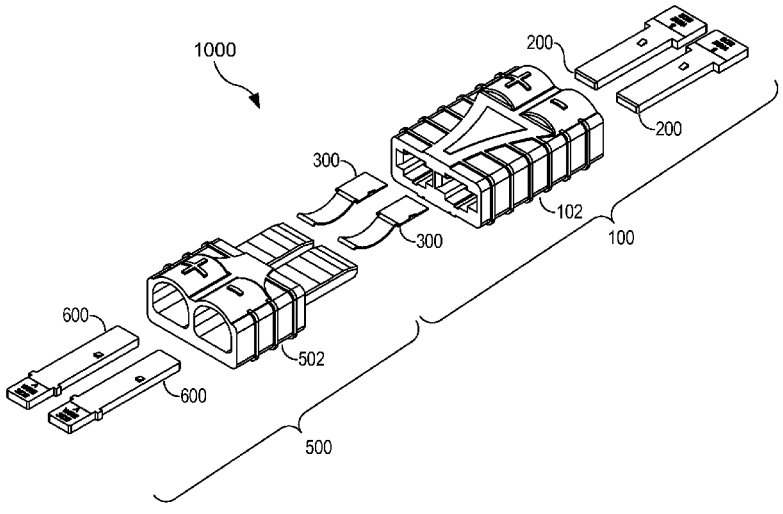
(57) **ABSTRACT**

An electrical connector is provided comprising a female member configured to couple with male member. The female member includes a female receptacle having an opening, and a female electrode is at least partially disposed within the female receptacle. A resilient member is configured to enhance electrical connection between the female electrode and a male connector electrode.

**59 Claims, 11 Drawing Sheets**



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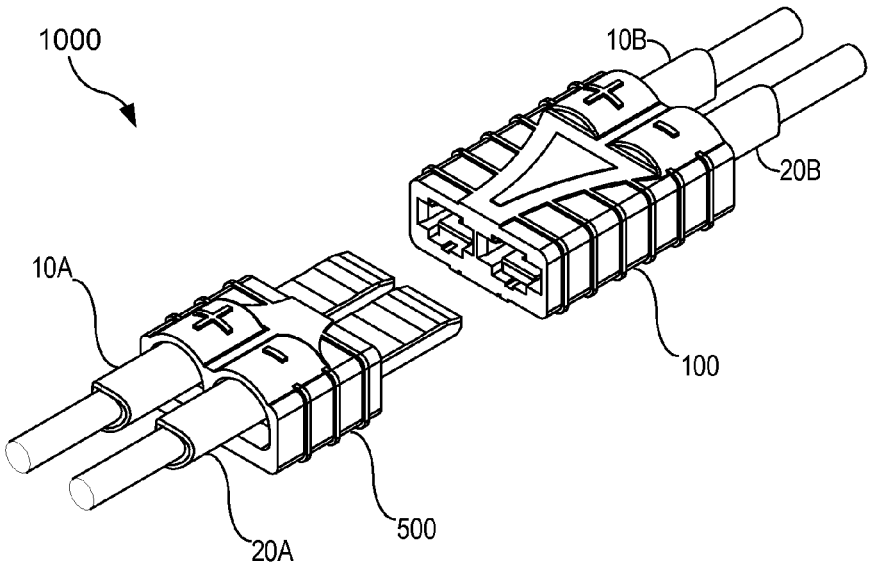
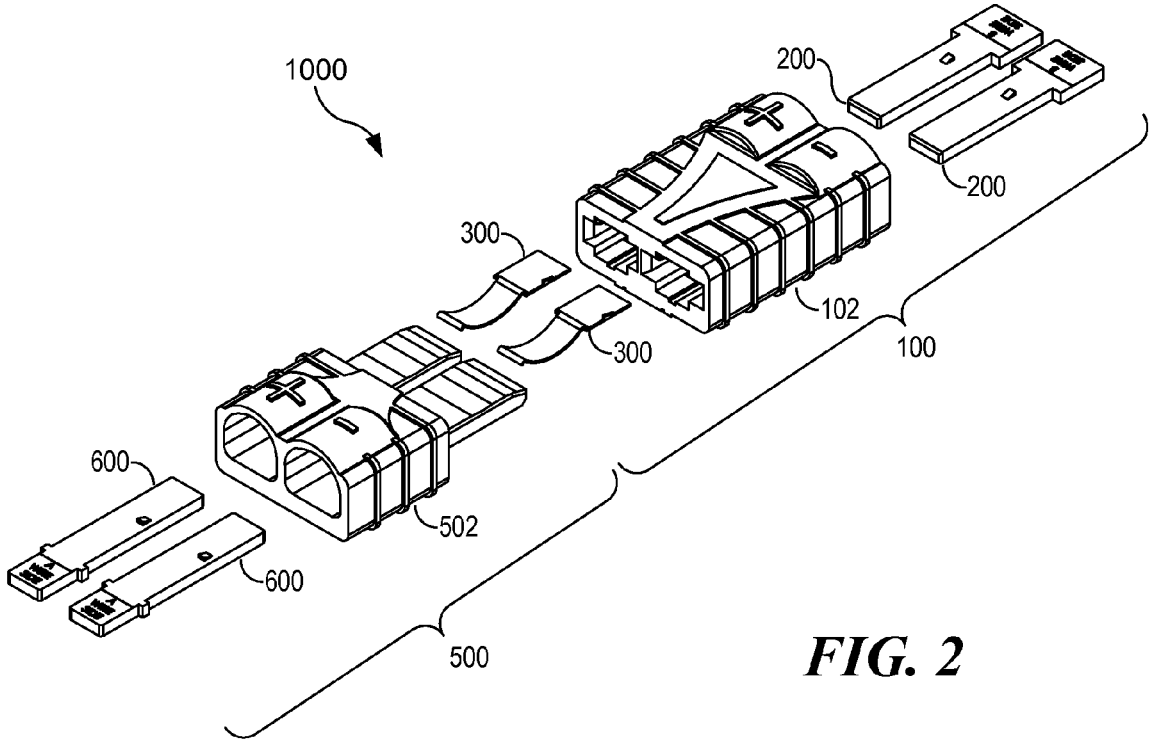

1000
10B
20B
10A
100
500
20A

*FIG. 1*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200
200
300
102
300
100
600
502
600
500

*FIG. 2*

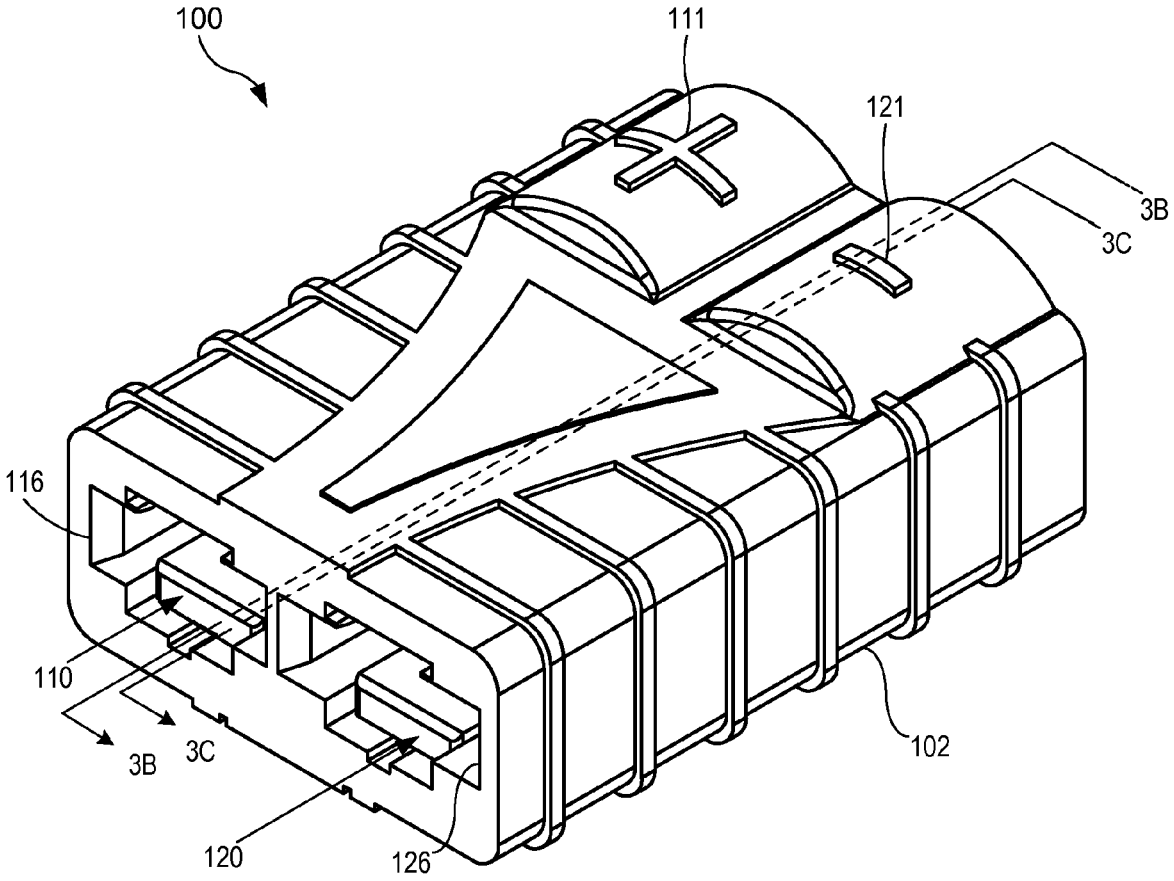



*FIG. 3A*

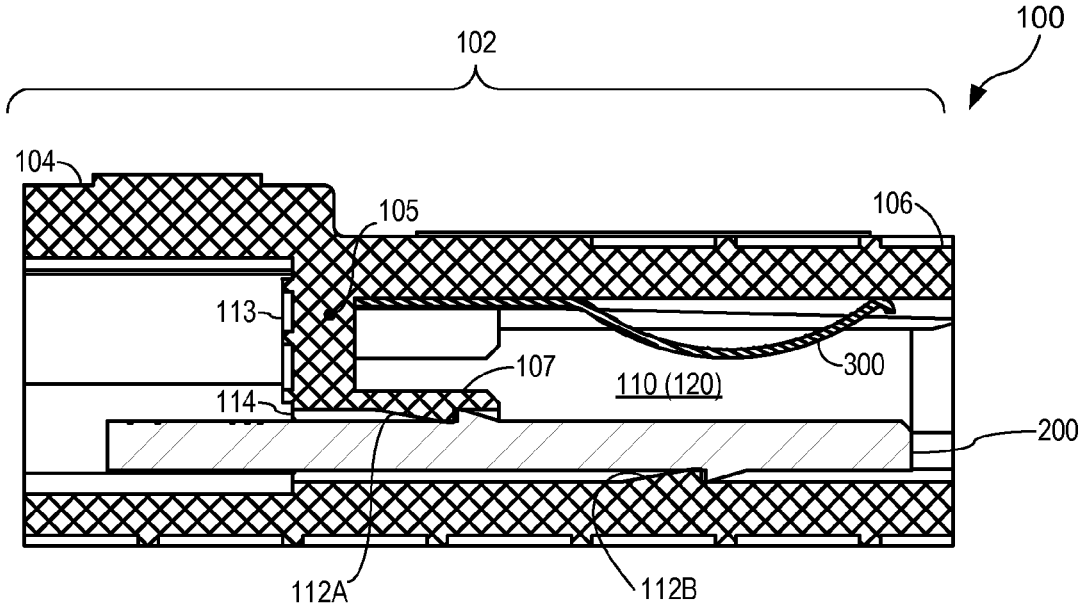
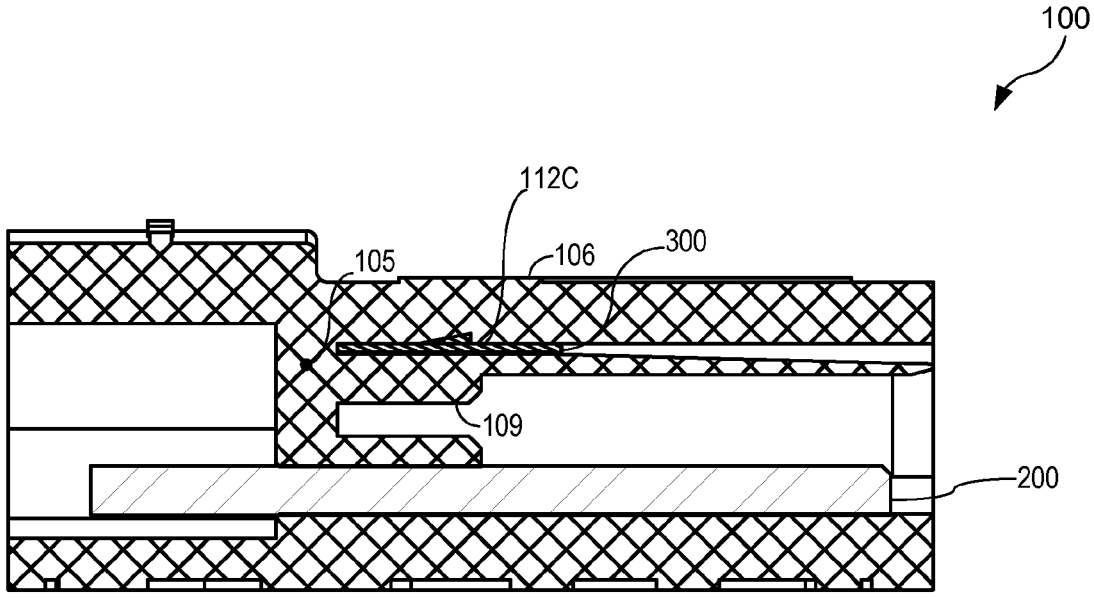

100
102
104
105
106
113
107
110 (120)
300
114
200
112A
112B

*FIG. 3B*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112C
105
106
300
109
200

*FIG. 3C*

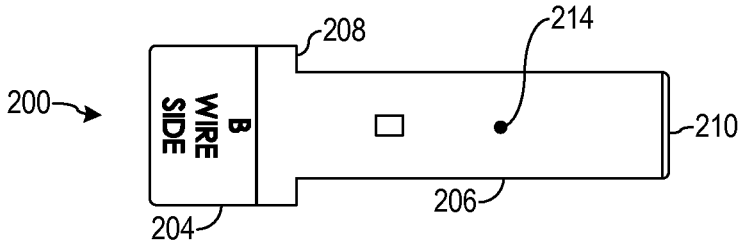



FIG. 4A

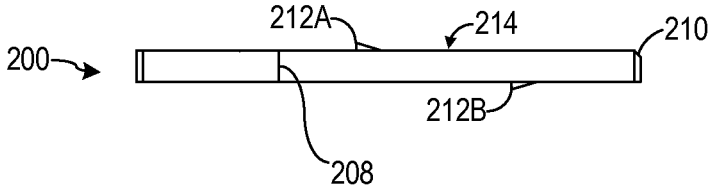



FIG. 4B

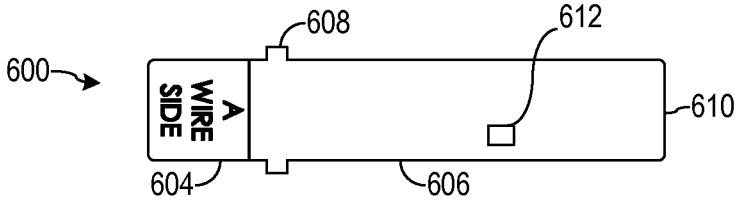



FIG. 7A

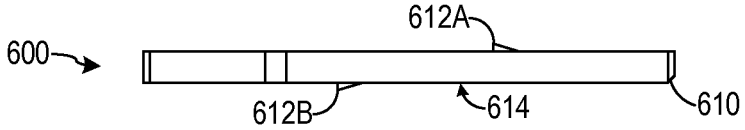



FIG. 7B

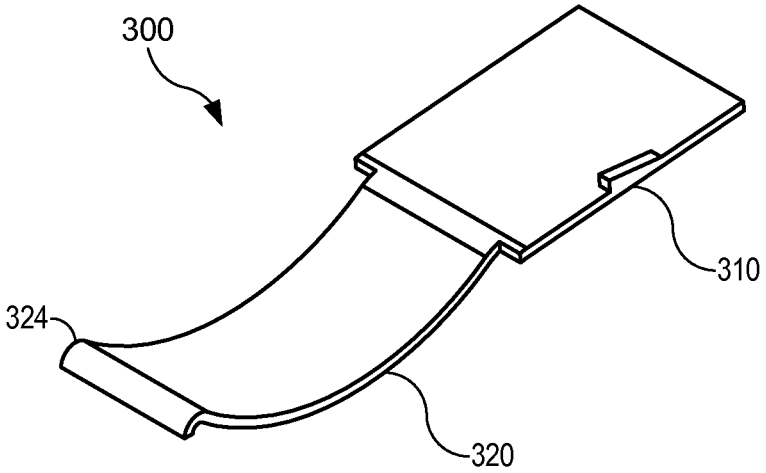



*FIG. 5A*

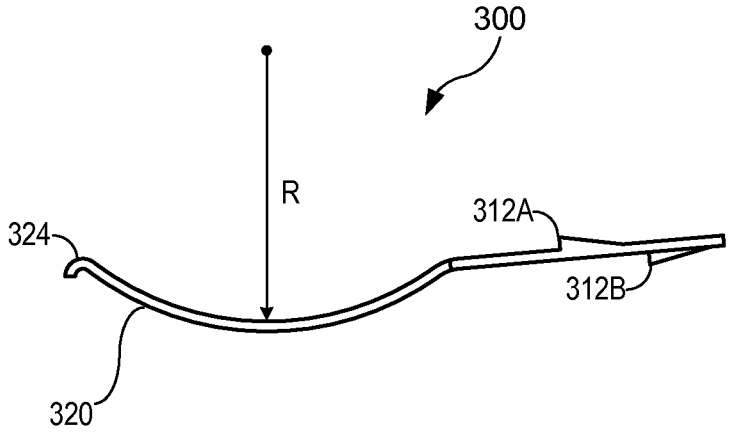



*FIG. 5B*

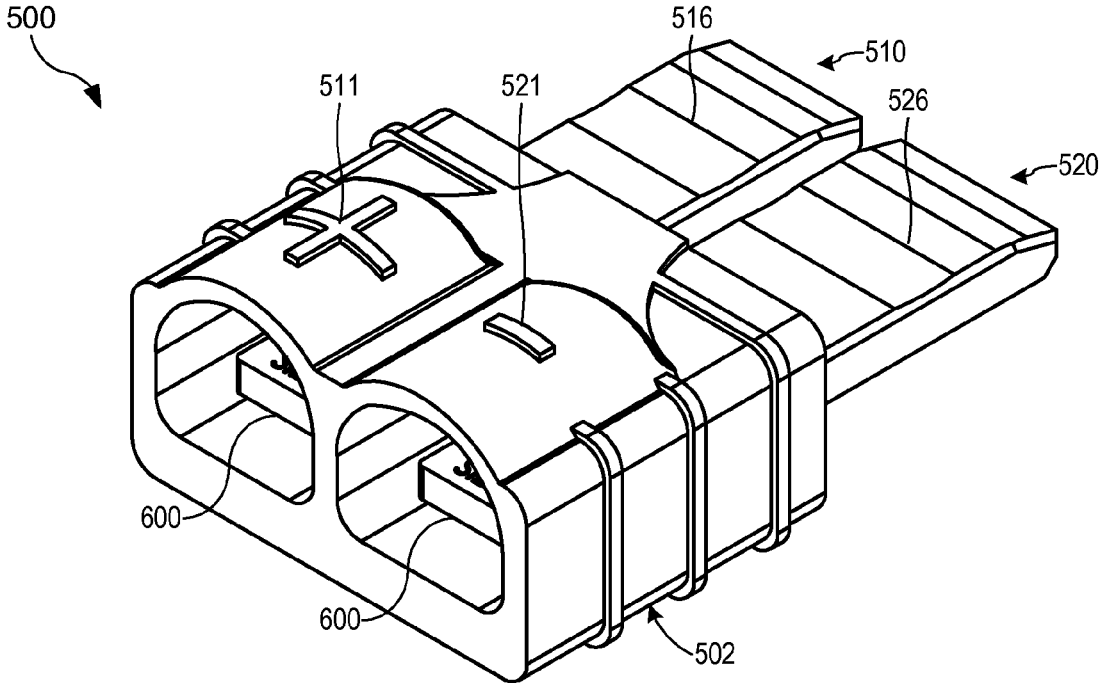

500
516
510
511
521
526
520
600
600
502

*FIG. 6A*

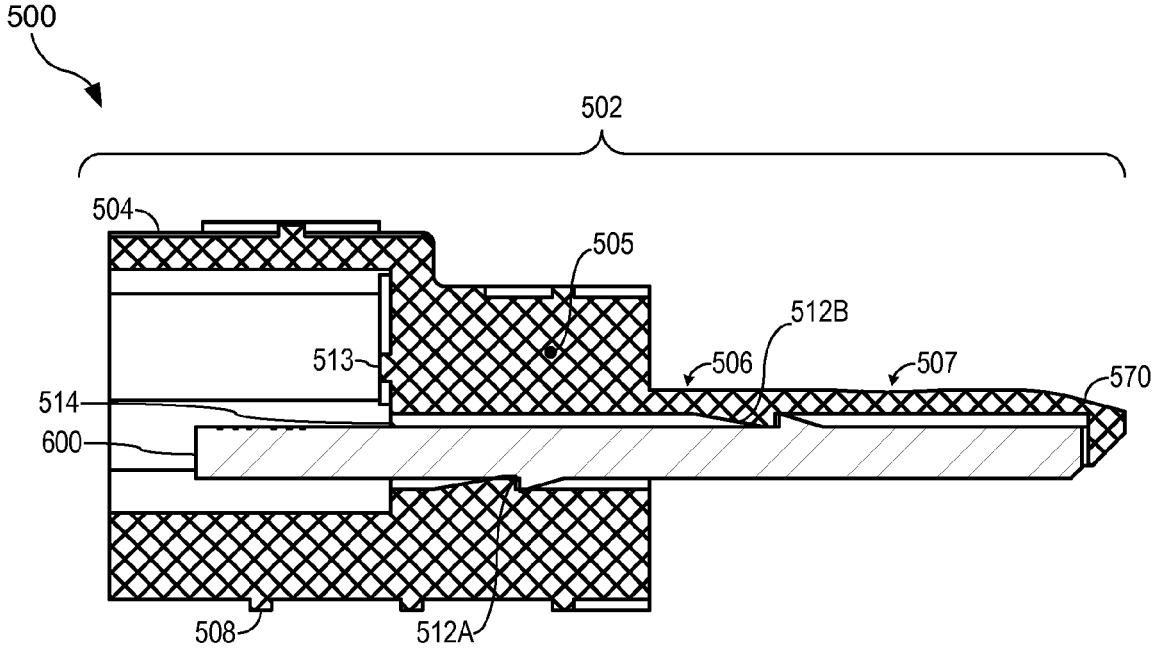

500
502
504
505
512B
513
506
507
570
514
600
508
512A

*FIG. 6B*

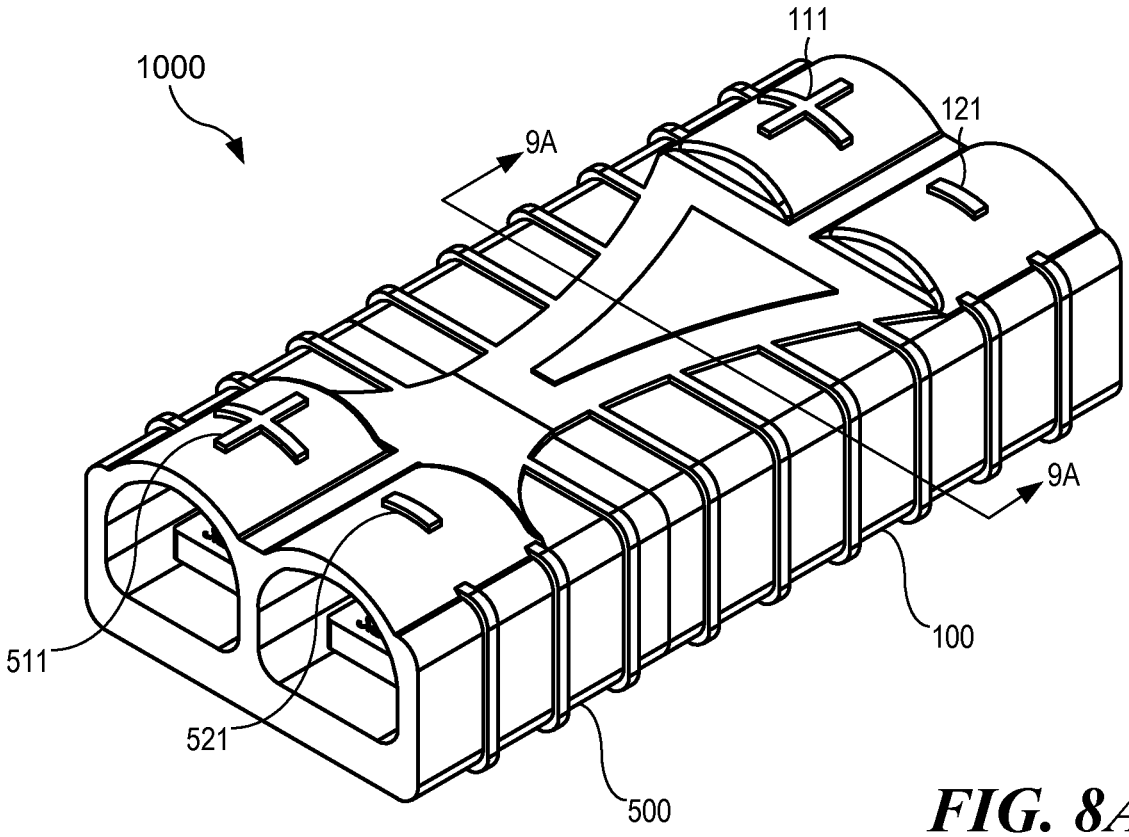

1000
111
121
9A
9A
511
521
500
100

FIG. 8A

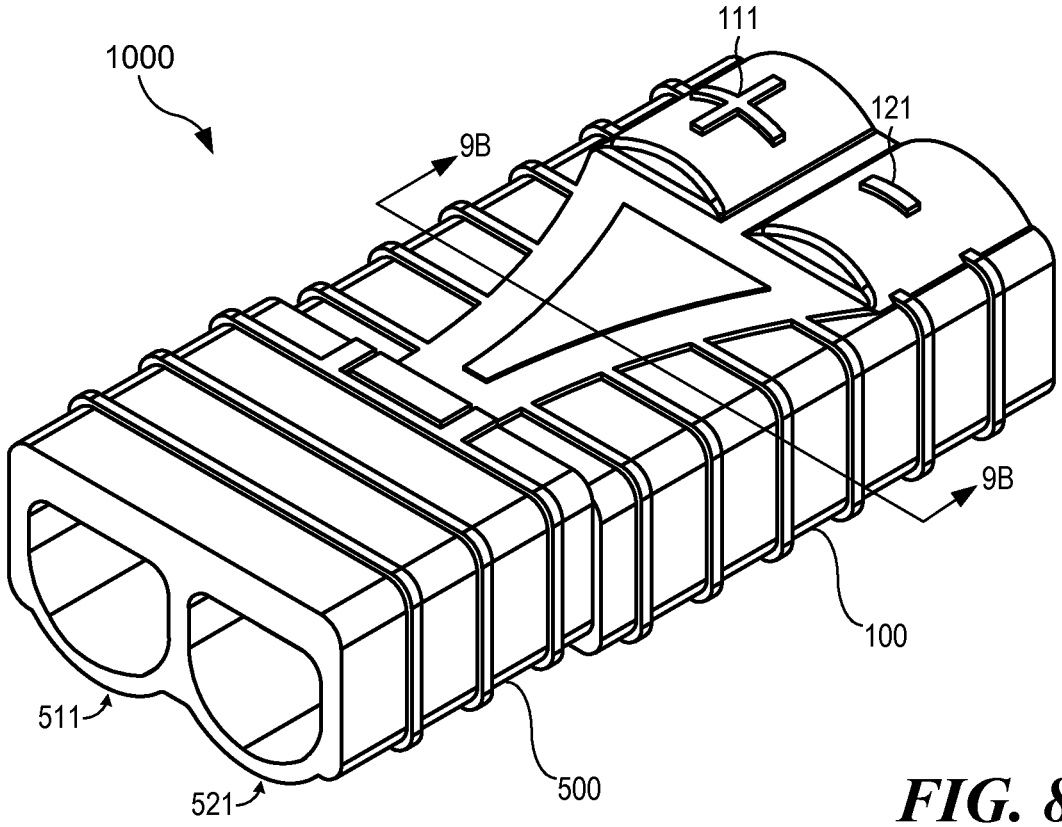

1000
111
121
9B
9B
511
521
500
100

FIG. 8B

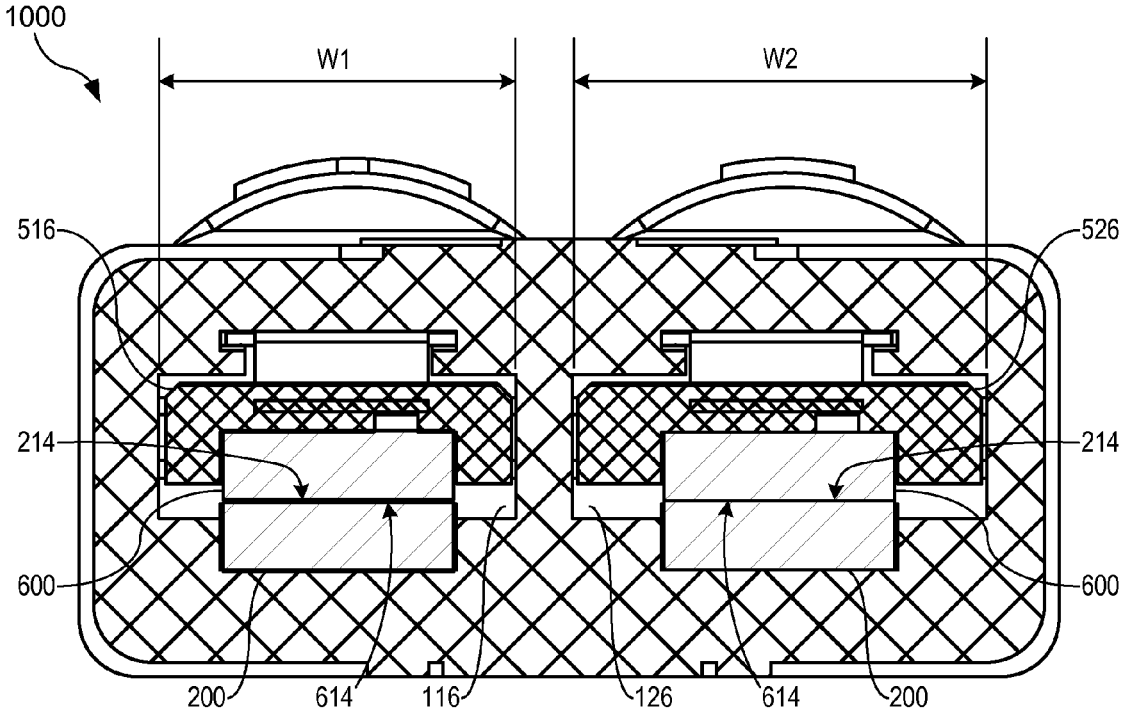

1000
W1
W2
516
526
214
214
600
600
200
614
116
126
614
200

*FIG. 9A*

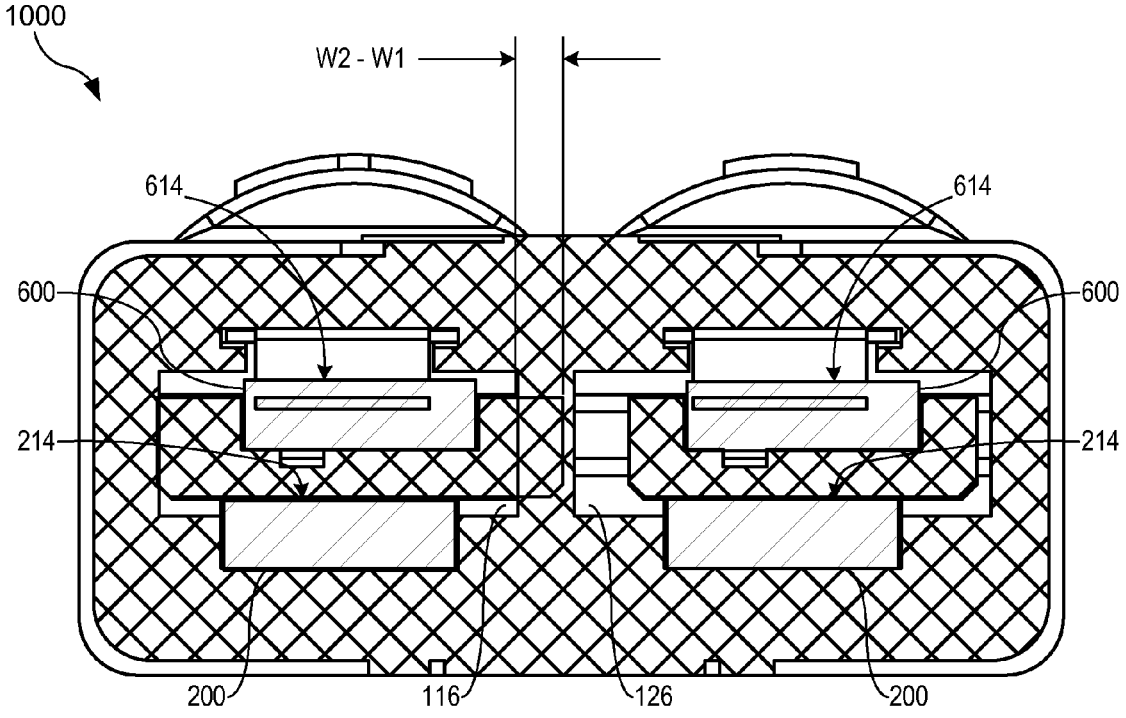
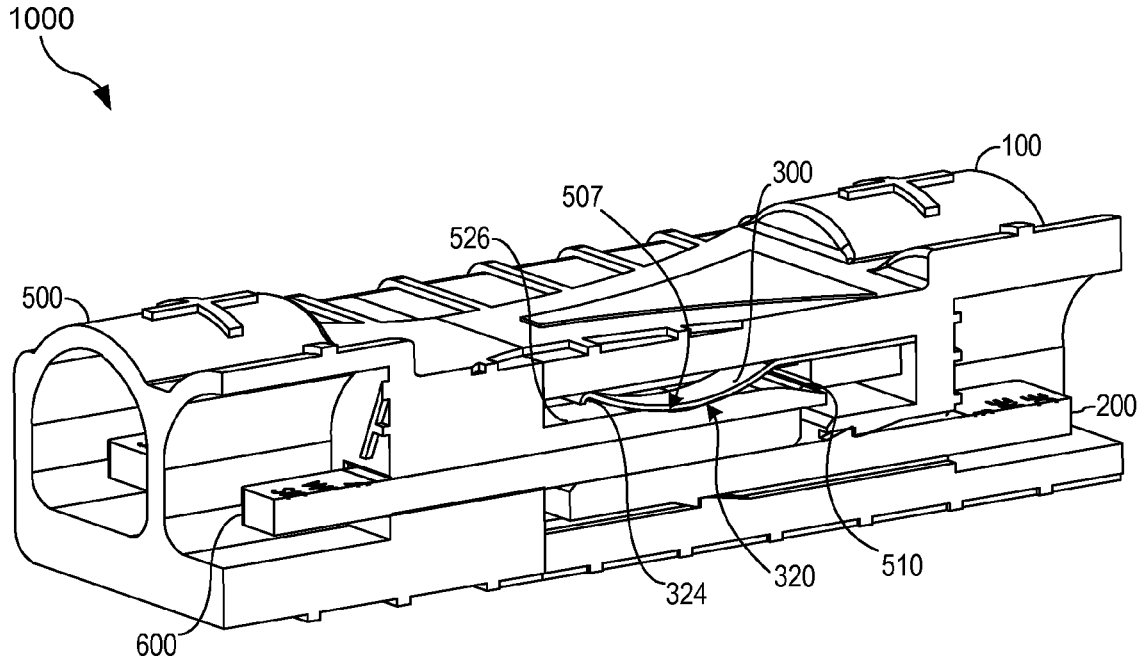

1000
W2 - W1
614
614
600
600
214
214
200
116
126
200

*FIG. 9B*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100
300
507
526
500
200
324
320
510
600

*FIG. 10*

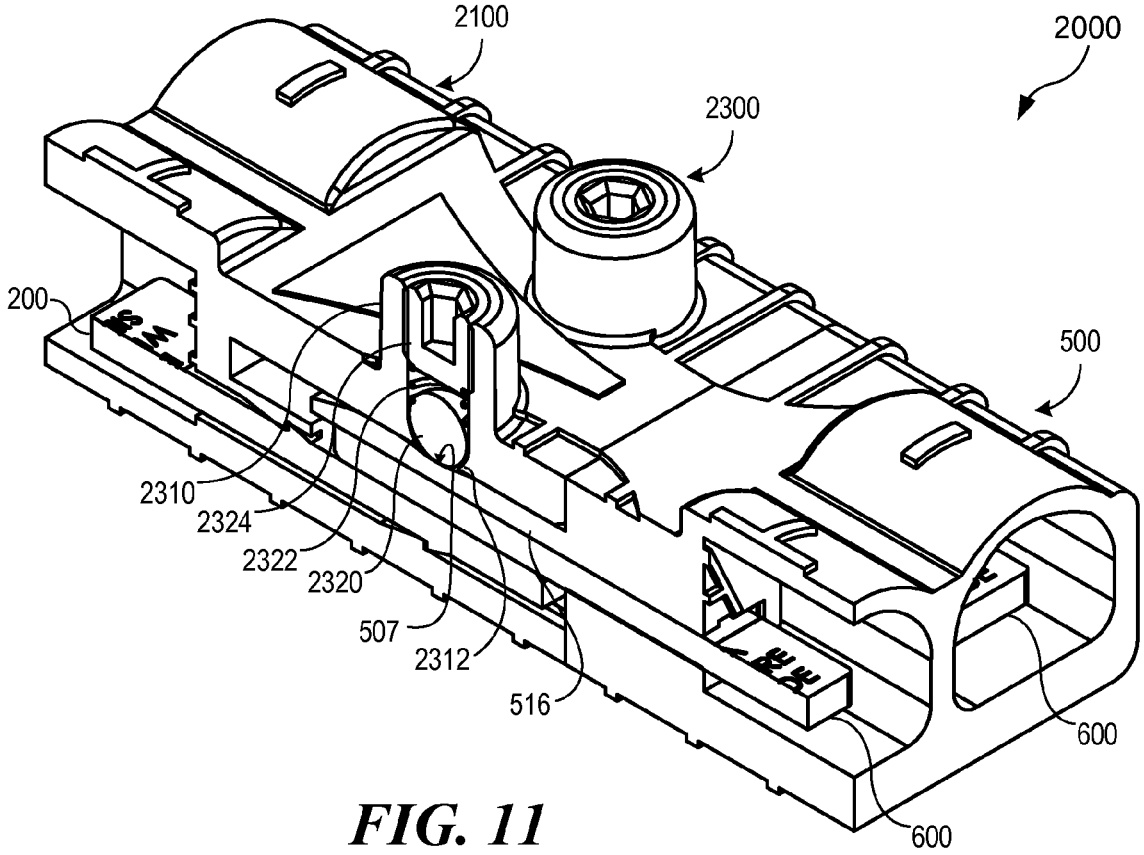
2100
2000
2300
200
500
2310
2324
2322
2320
507
2312
516
600
600

*FIG. 11*

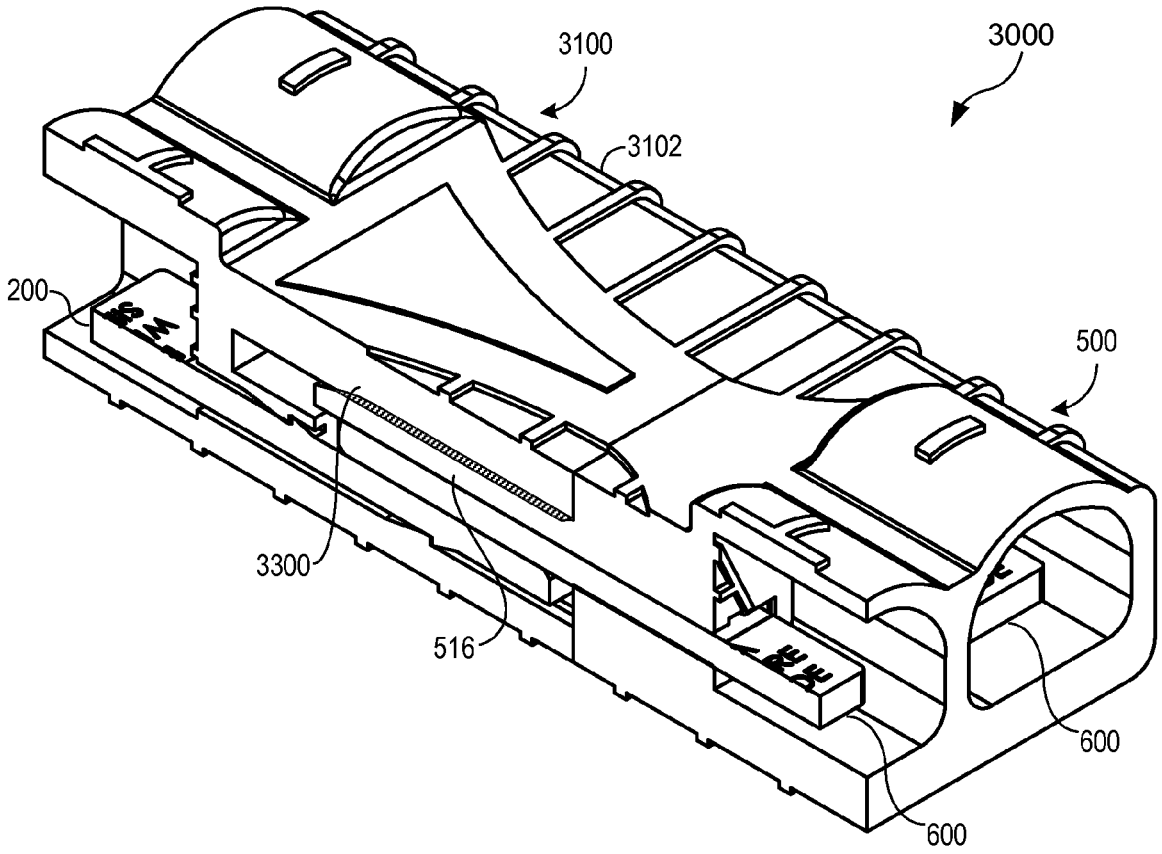


*FIG. 12*

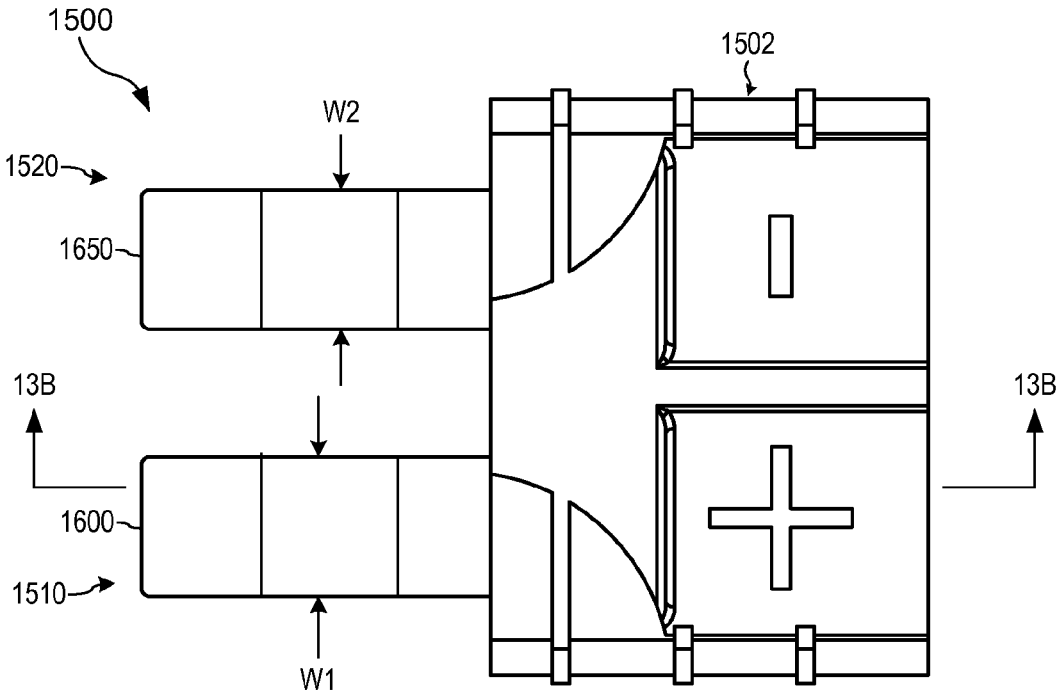


*FIG. 13A*

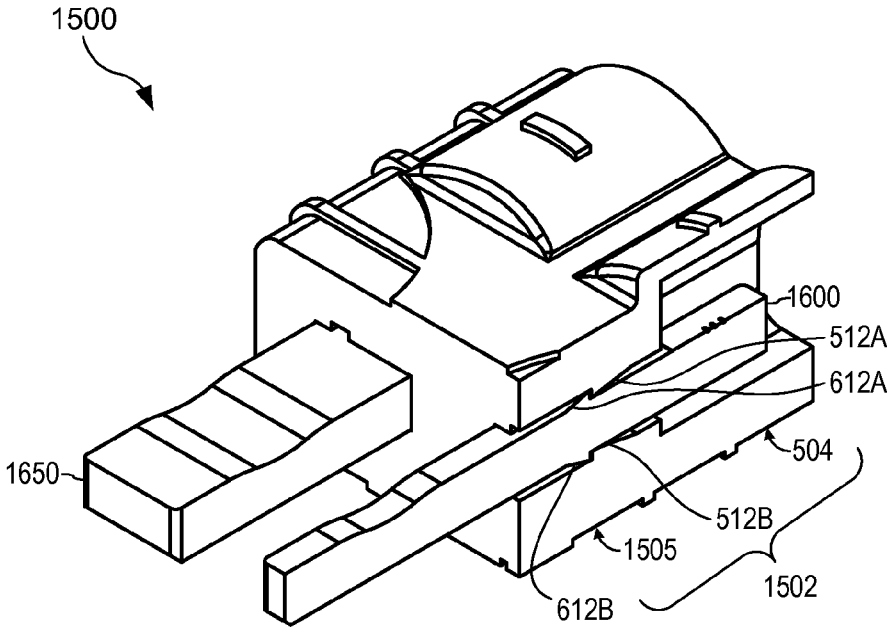


*FIG. 13B*

# ELECTRICAL CONNECTOR ASSEMBLY

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of, and claims the benefit of the filing date of, co-pending U.S. patent application Ser. No. 12/959,872 entitled ELECTRICAL CONNECTOR ASSEMBLY, filed Dec. 10, 2010, which is a continuation of U.S. patent application Ser. No. 12/417,792 entitled ELECTRICAL CONNECTOR ASSEMBLY, filed Apr. 3, 2009, now U.S. Pat. No. 7,867,038, which is a continuation of U.S. patent application Ser. No. 11/951,754 entitled ELECTRICAL CONNECTOR ASSEMBLY, filed Dec. 6, 2007, now U.S. Pat. No. 7,530,855, which is a continuation of U.S. patent application Ser. No. 11/736,460 filed Apr. 17, 2007, now U.S. Pat. No. 7,374,460.

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to electrical connectors and, more particularly, to high current electrical connectors with protection against reverse polarity connections.

2. Description of the Related Art

A wide variety of electronic devices are powered through the use of battery packs. For example, remotely controlled vehicles of all types may have an on-board rechargeable battery pack supplying stored electricity to an electric motor. In some of these lightweight vehicles, racing creates a demand for more powerful motors along with increasing levels of current capacity to energize the motors. As a battery pack is drained of the stored energy contained therein, a user must be able to easily exchange a depleted battery pack for a fully charged one. The depleted battery pack is then connected to a battery charger in order to be ready for the next exchange. Consequently, there exists a need for a high current electrical connector with a lightweight and compact design.

## SUMMARY OF THE INVENTION

In accordance with an embodiment of the present invention, an electrical connector having a lightweight and compact design is provided wherein a resilient member is configured to enhance electrical connection between a female electrode and a male connector electrode.

## BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following Detailed Description taken in conjunction with the accompanying drawings, in which:

FIG. **1** illustrates a general orthogonal top view of an embodiment of an electrical connector configured according to the present invention and showing attached wire conductors;

FIG. **2** illustrates an exploded assembly view of the electrical connector of FIG. **1**;

FIG. **3**A illustrates an orthogonal top view of a female member of the electrical connector of FIG. **1**;

FIG. **3**B illustrates a cross-sectional view of the female member of FIG. **3**A as viewed along line **3**B-**3**B;

FIG. **3**C illustrates a cross-sectional view of the female member of FIG. **3**A as viewed along line **3**C-**3**C;

FIG. **4**A illustrates a top view of a female terminal;



FIG. **4**B illustrates a side view of the female terminal of FIG. **4**A;

FIG. **5**A illustrates an orthogonal top view of a resilient member;

FIG. **5**B illustrates a side view of the resilient member of FIG. **5**A;

FIG. **6**A illustrates an orthogonal top view of a male member;

FIG. **6**B illustrates a cross-sectional side view of the male member of FIG. **6**A;

FIG. **7**A illustrates a top view of a male terminal;

FIG. **7**B illustrates a side view of the male terminal of FIG. **7**A;

FIG. **8**A illustrates an orthogonal top view of the electrical connector of FIG. **1** correctly assembled;

FIG. **8**B illustrates an orthogonal top view of the electrical connector of FIG. **1** incorrectly assembled;

FIG. **9**A illustrates a cross-sectional view of the correctly assembled electrical connector of FIG. **8**A as viewed along line **9**A-**9**A;

FIG. **9**B illustrates a cross-sectional view of the incorrectly assembled electrical connector of FIG. **8**B as viewed along line **9**B-**9**B;

FIG. **10** illustrates an orthogonal cross-sectional view of the assembled electrical connector of FIG. **1**;

FIG. **11** illustrates an orthogonal cross-sectional top view of another embodiment of an electrical connector configured according to aspects of the present invention;

FIG. **12** illustrates an orthogonal cross-sectional top view of another embodiment of an electrical connector configured according to aspects of the present invention;

FIG. **13**A illustrates a top view of another embodiment of a component of an electrical connector configured according to aspects of the present invention; and

FIG. **13**B illustrates an orthogonal cross-sectional top view of the component of FIG. **13**A as viewed along line **13**B-**13**B.

## DETAILED DESCRIPTION

In the following discussion, numerous specific details are set forth to provide a thorough understanding of the present invention. However, those skilled in the art will appreciate that the present invention may be practiced without such specific details. In other instances, well-known elements have been illustrated in schematic or block diagram form in order not to obscure the present invention in unnecessary detail. Additionally, for the most part, details concerning well known features and elements have been omitted inasmuch as such details are not considered necessary to obtain a complete understanding of the present invention, and are considered to be within the understanding of persons of ordinary skill in the relevant art.

Turning now to the drawings, FIG. **1** shows a top orthogonal view of an assembled electrical connector with attached wire conductors. In this drawing, reference numeral **1000** generally indicates an illustrative embodiment of an electrical connector **1000** at least partially configured according to the present invention. The electrical connector **1000** may comprise a female member **100** and a male member **500**. Attached to the electrical connector **1000** are wire conductors **10**A, **10**B, **20**A, and **20**B. The wire conductors **10**A, **10**B, **20**A, and **20**B, may not considered as components of the electrical connector **1000** and are shown for the purposes of illustration. Wire conductors **10**A and **10**B may carry a positive current flow and wire conductors **20**A and **20**B may carry a negative

current flow. The various components of the electrical connector **1000** will be described in more detail in the following illustrative embodiment.

Referring to FIG. **2**, the components of an embodiment of the electrical connector **1000** are shown in an exploded assembly view. The female member **100** may comprise a female housing **102**, a first and second female terminal **200**, and a first and second resilient member **300**. The male member **500** may comprise a male housing **502**, and a first and second male terminal **600**.

Female Member

Turning now to FIGS. **3**A, **3**B, and **3**C, the female member **100** may comprise a female housing **102**, a first female terminal chamber **110**, a second female terminal chamber **120**, female terminals **200**, and resilient members **300** (more clearly shown in FIG. **2**). A first female polarity indicator **111** and a second female polarity indicator **121** may indicate the respective polarities of the first female terminal chamber **110** and the second female terminal chamber **120**. A first orifice **116** and a second orifice **126** may be located at an end of the female member **100** opposite to the first and second female polarity indicators **111** and **121**. An example of a resilient member **300** is shown in FIGS. **3**B and **3**C. A resilient member **300** may be located in each of the first and second female terminal chambers **110** and **120** (however, only one is shown in the FIGS. **3**B and **3**C for the purposes of illustration). The various components of the female member **100** will be described in more detail in the following illustrative embodiment.

Female Housing

Referring to FIG. **3**B, the female housing **102** may be substantially rectangular in shape and comprise a female conductor housing **104**, a female internal wall **105**, and a female terminal housing **106**, for each of the first and second female terminal chambers **110** and **120**. Due to symmetry, only the first female terminal chamber **110** will be described from this point forward, reference numerals enclosed by parenthesis refer to the second female terminal chamber **120**. Although a substantially rectangular shape is shown for the female housing **102**, embodiments of the present invention may not be limited to this one configuration. Any configuration capable of accommodating one or more female terminals **200** may be used. The female housing **102** may be manufactured from a dielectric material able to withstand the operating conditions of an intended application and provide sufficient electrical insulation between the current carrying female terminals **200** (i.e., inhibiting the occurrence of electrical shorts between the female terminals **200**). For example, the material of the female housing **102** may be a glass reinforced nylon such as Zytel® 70G33L, made by DuPont®. In some applications the reinforced nylon material may comprise approximately 33% glass. The material may be used in a remotely controlled vehicle operating in a natural environment for example and may experience a temperature range from below −20° F. (−29° C.) to over 250° F. (121° C.) (e.g., when operated in desert conditions over solar heated roadways, or due to battery heat, current flow, and electrical resistance).

The female conductor housing **104** may be separated from the female terminal housing **106** by the female internal wall **105**. The female internal wall **105** may comprise an opening **114** (**124**) to accommodate a female terminal **200**. On the female conductor housing **104** side of the female internal wall **105**, the female internal wall **105** may comprise an indicator **113** identifying the connection side of the electrical connector **1000** (FIG. **1**) for example (e.g., "A" for the female member and "B" for the male member). In other embodiments, the indicator **113** may comprise a polarity sign to be used in place of, or in addition to, the first and second female polarity indicators **111** and **121** (FIG. **3**A).

The female conductor housing **104** may circumferentially surround an end of a female terminal **200** inserted into each of the first and second female terminal chambers **110** and **120**. An end of the female conductor housing **104** opposing the female internal wall **105** may be open to provide access for a conductor (not shown) to contact an exposed end of a female terminal **200**. In other embodiments, an end or side of the female conductor housing **104** adjacent to the female internal wall **105** may be open to provide conductor access. In the embodiment shown, the female conductor housing **104** substantially shrouds and insulates the ends of the female terminals **200** from each other. In certain other embodiments the female conductor housing **104** may only partially surround an end of a female terminal **200** in each of the first and second female terminal chambers **110** and **120**.

The female terminal housing **106** portions of each of the first and second female terminal chambers **110** and **120** may comprise a female terminal support **107** and a resilient member support **109** (FIG. **3**C). Each of the female terminal supports **107** may help to retain a corresponding female terminal **200** in the respective first and second female terminal chambers **110** and **120**. The female terminal support **107** may comprise one or more retention members **112** (for example as represented by **112**A) configured to retain a female terminal **200** after assembly into a female member **100**. Although a slanted ramp type of retention member **112** is shown in FIG. **3**B to facilitate an insertion type of assembly (e.g., inserting a female terminal **200** from left to right in the female housing **102** with respect to FIG. **3**B), a person of ordinary skill in the art would not be limited to just this type of retention member **112**. Pins, rivets, fasteners, other mechanical attachments, welding, and chemical adhesives, among other various methods may be used to secure a female terminal **200** in the female housing **102**. Further, similar additional retention members **112**B may be used to provide additional force to oppose the friction force generated during the assembly and disassembly of the electrical connector **1000** (FIG. **1**) that may otherwise move or dislocate one or both of the female terminals **200**. Other embodiments of the female member **100** may not comprise retention members **112**. In some cases the female terminals **200** and resilient members **300** may be core molded into the female member **100** at the time of manufacture.

The resilient member support **109** (FIG. **3**C) may secure a resilient member **300** in each of the first and second female terminal chambers **110** and **120**. The resilient member support **109** is shown as proximate to the female internal wall **105**. However, an embodiment of the resilient member support **109** may be located proximate to an end of the female terminal housing **106** opposite to the female internal wall **105** (i.e., the insertion end of the female terminal housing **106**, for example, essentially configured 180° in a horizontal plane relative to the embodiment shown in FIG. **3**B) in addition to other locations. As with the female terminal support **107**, the resilient member support **109** may comprise one or more retention features **112**, for example, as represented by **112**C in FIG. **3**C. The retention features **112** of the resilient member support **109** may comprise slanted ramp protrusions as with an embodiment of the female terminal support **107**, or the retention features **112** may comprise any of the mechanical, chemical, or welding methods of fastening previously recited. The previously recited methods of retaining and/or fastening female terminals **200** and resilient members **300** are not intended to form an exhaustive list, but are merely a sampling from amongst a broad variety of retaining and fas-

tening methods known to those of ordinary skill in the art. As with the female terminals **200**, the resilient members **300** may be core molded into the female housing **102** during the production of the female housing **102**.

The ends of the first and second female terminal chambers **110** and **120** located in the female terminal housing **106**, opposite to the female internal wall **105**, are referred to as the first and second orifices **116** and **126**. Each of the first and second orifices **116** and **126** may be configured substantially in a rectangular shape as shown in FIG. **3**A. However, in the illustrative embodiment shown in these figures, an aspect of the first orifice **116**, such as a width, may be configured differently than the same aspect of the second orifice **126**. The difference in widths may inhibit an incorrectly polarized assembly of a male member **500** (FIG. **1**) with the female member **100**. Although a difference in dimensional aspects such as widths may be used to inhibit reversing the polarities during connection of an electrical connector **1000** (FIG. **1**) the present invention may not be limited to this method. Different configurations, devices, and dimensions may be used to facilitate the proper polar connection orientation during assembly of a male member **500** with a female member **100**.

Female Terminals

Turning now to FIGS. **4**A and **4**B, FIG. **4**A shows a top view of an embodiment of a female terminal **200**, and FIG. **4**B shows a side view of the female terminal **200** of FIG. **4**A. As an example of an illustrative embodiment of a female terminal **200**, the female terminal **200** may comprise a terminal connector portion **204** and a terminal contact portion **206**. The female terminal **200** may comprise an electrically conductive material, such as brass, copper, or bronze. The female terminal **200** may be plated with gold (such as a gold-cobalt or gold-nickel alloy) or silver, among other materials, preferably copper plated with nickel and then plated with gold (for example), in order to increase the electrical conductivity between contacting portions of the male and female terminals **600** and **200**. The female terminal **200** shown may be made from a standard plate of material and punched formed to the correct size and configuration, among other methods of forming.

The terminal connector portion **204** may be located on one end of the female terminal **200** and configured to electrically couple with a copper wire conductor (for example) such as wire conductors **10**B and **20**B (FIG. **1**). The terminal connector portion **204** may be electrically coupled to a wire conductor through the use of soldering, mechanical fastening (e.g., through the use of a screw clamp), standard insulated and non-insulated connector fittings, crimping, and other methods of electrically coupling a wire conductor to a portion of a terminal. Embodiments of the terminal connector portion **204** may comprise a variety of configurations in order to accommodate a particular electrical coupling method.

The terminal contact portion **206** may be located at an opposite end of the female terminal **200** relative to the terminal connector portion **204**, and may comprise an angled end **210**, one or more terminal retention features **212** (two are shown in FIGS. **4**B, **212**A and **212**B), and a contact surface **214**. The angled end **210** may help facilitate the coupling or assembly of a corresponding male terminal **600** (FIG. **2**) during the connection of an electrical connector **1000** (FIG. **1**). The contact surface **214** may directly contact an opposing surface of a male terminal **600** in order to allow an electrical current to flow from one end of the electrical connector **1000** to the other.

Terminal step **208** may separate the terminal connector portion **204** from the terminal contact portion **206**. In some embodiments, during assembly of the female terminal **200** into female housing **102** (FIG. **3**B), the terminal step **208** may oppose a portion of the female housing **102** and prevent further movement in the assembly direction. The terminal retention features **212** may contact corresponding retention features **112** of the female housing **102** and prevent movement in a direction opposite to the assembly direction. At this point, the female terminal **200** may be substantially securely coupled with the female housing **102**.

Resilient Member

Referring now to FIGS. **5**A and **5**B, these figures respectively show an orthogonal top view of a resilient member **300** and a side view of the resilient member **300** of FIG. **5**A. The resilient member **300** may comprise a resilient base member **310** and a resilient contact member **320**. The resilient member **300** may be punch formed from a sheet of stainless steel (e.g., SS **301** with no plating), spring steel (e.g., spring steel with nickel plating) or other resilient material configured to work within the anticipated environmental conditions of the electrical connector **1000** (FIG. **1**). In some embodiments, the resilient member **300** may be plated or otherwise coated to inhibit rust or to provide an appropriate level of resistance (e.g., friction force) necessary to maintain the connection between an assembled male member **500** and female member **100**.

The resilient base member **310** may be located at one end of the resilient member **300** and comprise one or more resilient retention members **312**A and **312**B (FIG. **5**B). The resilient retention members **312**A and **312**B may engage corresponding retention members **112** within the resilient member support **109** (as seen in FIG. **3**C, but only one retention member **112**C can be seen in this view), located in each of the first and second terminal chambers **110** and **120**. The resilient retention members **312**A and **312**B may securely retain the resilient members **300** within the female housing **102** during assembly and disassembly of the electrical connector **1000** (FIG. **1**). The resilient base member **310** is shown as a substantially flat quadrilateral but embodiments of the present invention may not be limited to this illustrative form. The resilient base member **310** may be retained separate from the corresponding female terminal **200** and separate from a fully inserted male terminal **500** (FIG. **2**). In other words, the resilient base member **310** may not overlay a corresponding male terminal **500** when an electrical connector **1000** (FIG. **1**) is electrically coupled.

As more easily seen in FIG. **5**B, the resilient contact member **320** may comprise an arcuate portion defined by a radius R. The arcuate portion may be resiliently deformed toward the radial center point in response to pressure or interference from portions of an installed male member **500** (FIG. **1**). The arcuate portion may also be configured to interface with a depression or other engaging feature, detailed later, in an opposing surface or portion of the male member **500** in order to provide a disassembly retention force after coupling the male member **500** with the female member **100** (see FIG. **1**). In the illustrative embodiment shown, only a single arcuate portion is illustrated in FIGS. **5**A and **5**B. However, embodiments of the present invention are not to be limited to this one exemplary configuration. For example, larger and smaller radii either alone or in combination with one or more relatively straight portions may be used, an arcuate portion curving back upon the resilient contact member **320**, a single angular bend joining two straight portions together, or a plurality of angular or arcuate portions such as in a zig-zag or wave type of configuration may be used in order to more evenly apply a force from the female member **100** to the male member **500**. The listing is intended to provide a small rep-

resentative sample of the various potential configurations consistent with the present invention and is not intended to be exhaustive.

One end of the resilient contact member **320** may comprise a housing interface **324**. An example of the housing interface **324** may be illustrated by a small radius curve rotating in an opposite direction relative to the arcuate portion defined by the radius R. The housing interface **324** may facilitate a sliding movement along a contacting portion of an inner wall of the female housing **102** (FIG. **3**B) in response to assembly and disassembly of a male member **500** and a female member **100** (see FIG. **2**). The sliding contact may prevent or inhibit the abrading or prematurely wearing down of the inner surface of the female housing **102** over a multiple number of connections and disconnections of the electrical connector **1000** (FIG. **1**). In this example, the contacting portion of the housing interface **324** curves away from the inner surface of the female housing **102** in directions tangent to the small radius curve. Further, the resilient contact member **320** may extend at an angle from the resilient base member **310** such that the housing interface **324** may be located above (with respect to FIG. **5**B) a plane containing the resilient base member **310**. This configuration may apply a pre-load to an assembled resilient member **300** via the housing interface **324**. By adjusting the angle for the resilient contact member **320** relative to the resilient base member **310**, and/or adjusting the radius R, the force applied to the male member **500** through the resilient contact member **320** may be adjusted. Adjusting the force of the resilient contact member **320** may adjust the amount of insertion and withdrawal force for the connecting and disconnecting of the electrical connector **1000**. Consequently, a desired amount of insertion and withdrawal force may be established for the connecting and disconnecting of the electrical connector **1000**.

Male Member

Turning now to FIGS. **6**A, and **6**B, the male member **500** may comprise a male housing **502**, a first male terminal extension **510**, a second male terminal extension **520**, and male terminals **600** (more clearly shown in FIG. **6**B). A first male polarity indicator **511** and a second male polarity indicator **521** may indicate the respective polarities of the first male terminal extension **510** and the second male terminal extension **520**. An example of a male terminal **600** is shown in FIGS. **7**A and **7**B and is detailed later. The various components of the male member **500** will be described in more detail in the following illustrative embodiment.

Male Housing

Referring to FIG. **6**B, the male housing **502** may be substantially rectangular in shape and comprise a male conductor housing **504**, a male internal wall **505**, and a male terminal tip **506** for each of the first and second male terminal extensions **510** and **520**. Due to their similarities, only the first male terminal extension **510** will be described from this point forward, reference numerals enclosed by parenthesis refer to second male terminal extension **520**. Although a substantially rectangular shape is shown for the male housing **502**, embodiments of the present invention may not be limited to this one configuration. Any configuration capable of accommodating one or more male terminals **600** may be used. The male housing **502** may be manufactured from a dielectric material able to withstand the operating conditions of an intended application and provide sufficient electrical insulation between the current carrying male terminals **600** (i.e., inhibiting the occurrence of an electrical short between the male terminals **600**). For example, the material of the male housing **502** may be a glass reinforced nylon such as Zytel® 70G33L, made by DuPont®. In some applications the reinforced nylon material may comprise approximately 33% glass. The material may be used in a remotely controlled vehicle operating in a natural environment for example and may experience a temperature range from below −20° F. (−29° C.) to over 250° F. (121° C.) (e.g., when operated in desert conditions over solar heated roadways, or due to battery heat, current flow, and electrical resistance).

The male conductor housing **504** may be separated from the male terminal housing **506** by the male internal wall **505**. The male internal wall **505** may comprise an opening **514** (**524**) to accommodate a male terminal **600**. On the male conductor housing **504** side of the male internal wall **505**, the male internal wall **505** may comprise an indicator **513** identifying the connection side of the electrical connector **1000** (FIG. **1**), for example (e.g., "A" for the female member and "B" for the male member). In other embodiments, the indicator **513** may comprise a polarity sign to be used in place of, or in addition to, the first and second male polarity indicators **511** and **521** (FIG. **6**A).

The male conductor housing **504** may circumferentially surround an end of a male terminal **600** inserted into each of the first and second male terminal extensions **510** and **520**. An end of the male conductor housing **504** opposing the internal wall **505** may be open to provide access for a conductor (not shown) to contact an exposed end of a male terminal **600**. In other embodiments, an end or side of the male conductor housing **504** adjacent to the male internal wall **505** may be open to provide conductor access. In the embodiment shown, the male conductor housing **504** substantially shrouds and insulates the ends of the male terminals **600** from each other. In certain other embodiments the male conductor housing **504** may only partially surround an end of a male terminal **600** in each of the first and second male terminal extensions **510** and **520**.

The male internal wall **505** of each of the first and second male terminal extensions **510** and **520** may function as a male terminal support (FIG. **6**B). Each of the male terminal supports (i.e., male internal walls **505**) may help to retain a corresponding male terminal **600** in the respective first and second male terminal extensions **510** and **520**. The male terminal support may comprise one or more retention members **512** (for example as represented by **512**A), configured to retain a male terminal **600** after assembly into a male member **500**. Although a slanted ramp type of retention member **512** is shown in FIG. **6**B to facilitate an insertion type of assembly (e.g., inserting a male terminal **600** from the left to the right in the male housing **502** with respect to FIG. **6**B), a person of ordinary skill in the art would not be limited to just this type of retention member **512**. Pins, rivets, fasteners, other mechanical attachments, welding, and chemical adhesives, among other various methods may be used to secure a male terminal **600** within the male housing **502**. Further, similar additional retention members **512**B may be used to provide additional force to oppose the friction force generated during the connection and disconnection of the electrical connector **1000** (FIG. **1**) that may otherwise move or dislocate one or both of the male terminals **600**. Other embodiments of the male member **500** may not comprise retention members **512**. In some cases the male terminals **600** may be core molded into the male housing **502** at the time of manufacture.

The ends of the first and second male terminal extensions **510** and **520** in the male terminal tips **506**, opposite to the internal wall **505**, are referred to as the first and second male terminal covers **516** and **526**. Each of the first and second male terminal covers **516** and **526** may be configured substantially in a rectangular shape as shown in FIG. **6**A. However, in the illustrative embodiment shown in these figures, an

aspect of the first male terminal cover **516**, for example width, may be configured differently than the same aspect of the second male terminal cover **526**. The difference in widths may inhibit an incorrectly polarized assembly of a male member **500** (FIG. **1**) with the female member **100**. Although a difference in dimensional aspects such as widths may be used to inhibit reversing the polarities during connection of an electrical connector **1000** (FIG. **1**), the present invention may not be limited to this method. Different configurations, devices, and dimensions may be used to facilitate the proper polar connection orientation during assembly of a male member **500** with a female member **100**.

The first and second male terminal covers **516** and **526** may each comprise a connector retention feature **507**. In some embodiments, the connector retention feature **507** may be configured as an arcuate cavity or depression corresponding to an arcuate portion of the resilient contact member **320** of a resilient member **300** (see FIG. **5**B). As the male member **500** is connected to the female member **100** (see FIG. **1**), the resilient member **300** moves relative to a surface of the corresponding first and second male terminal covers **516** and **526** until a portion of the resilient contact member **320** engages a corresponding portion of the connector retention feature **507**. The engagement between the resilient contact member **320** and the connector retention feature **507** may provide a sensory indication that the male member **500** is fully connected to the female member **100**. In addition, the engagement between the resilient contact member **320** and the connector retention feature **507** may help to prevent inadvertent disconnection between the male member **500** and the female member **100** during the operation of the electrical connector **1000** in an applied device.

The first and second male terminal covers **516** and **526** may further comprise an angled or slanted portion **570**, which may be located at an end opposite to the male internal wall **505**. The slanted portion **570** of each of the first and second male terminal covers **516** and **526** may facilitate the insertion and/or assembly of the male member **500** with the female member **100** (see FIG. **1**). In some embodiments, rounded, arcuate, or other insertion facilitating features may be used in place of, or in addition to, the slanted portion **570** of each of the first and second male terminal covers **516** and **526**. At least part of the remaining portions of the first and second male terminal covers **516** and **526** may provide a contact surface for the resilient member **300**, as previously explained, and may provide a degree of insulation between the resilient members **300** and the male terminals **600**. The material of the first and second male terminal covers **516** and **526** may be the same as the material used for the rest of the male housing **502**. In some embodiments, the first and second male terminal covers **516** and **526** may comprise a coating applied to a surface of the male terminals **600**. Alternatively, a coating or texture may be applied to a surface of the first and second male terminal covers **516** and **526** to vary the level of frictional resistance between the surface and the contacting portion of the resilient contact member **320** of each of the respective resilient members **300**.

Male Terminals

Turning now to FIGS. **7**A and **7**B, FIG. **7**A shows a top view of an embodiment of a male terminal **600**, and FIG. **7**B shows a side view of the male terminal **600** of FIG. **7**A. As an example of an illustrative embodiment of a male terminal **600**, the male terminal **600** may comprise a terminal connector portion **604** and a terminal contact portion **606**. The male terminal **600** may comprise an electrically conductive material, such as brass, copper, or bronze. The male terminal **600** may be plated with gold (such as gold-cobalt or gold-nickel alloy) or silver, among other materials, preferably copper plated with nickel and then plated with gold (for example), in order to increase the electrical conductivity between contacting portions of the male and female terminals **600** and **200**. The male terminal **600** shown may be made from a standard plate of material and punched formed to the correct size and configuration, among other methods of forming.

The terminal connector portion **604** may be located on one end of the male terminal **600** and configured to electrically couple with a copper wire conductor (for example) such as wire conductors **10**A and **20**A (FIG. **1**). The terminal connector portion **604** may be electrically coupled to a wire conductor through the use of soldering, mechanical fastening (e.g., through the use of a screw clamp), standard insulated and non-insulated connector fittings, crimping, and other methods of electrically coupling a wire conductor to a terminal. Embodiments of the terminal connector portion **604** may comprise a variety of configurations in order to accommodate a particular electrical coupling method.

The terminal contact portion **606** may be located at an opposite end of the male terminal **600** relative to the terminal connector portion **604**, and may comprise an angled end **610**, one or more terminal retention features **612** (two are shown in FIGS. **7**B, **612**A and **612**B), and a contact surface **614**. The angled end **610** may help facilitate the coupling or assembly of a corresponding female terminal **200** (FIG. **2**) during the connection of an electrical connector **1000** (FIG. **1**). The contact surface **614** may directly contact an opposing surface of a female terminal **200** in order to allow an electrical current to flow from one end of the electrical connector **1000** to the other.

Terminal step **608** may separate the terminal connector portion **604** from the terminal contact portion **606**. In some embodiments, during assembly of the male terminal **600** into male housing **502** (FIG. **6**B), the terminal step **608** may oppose a portion of the male housing **502** and prevent further movement in the assembly direction. The terminal retention features **612** may contact corresponding retention features **512** of the male housing **502** and prevent movement in a direction opposite to the assembly direction. At this point, the male terminal **600** may be substantially securely coupled with the male housing **502**.

Assembly

Turning now to FIGS. **8**A and **8**B, FIG. **8**A illustrates a correctly assembled electrical connector **1000**, while FIG. **8**B illustrates an incorrectly assembled electrical connector **1000**. As seen in FIG. **8**A, when the male member **500** is correctly coupled to a female member **100**, the first and second male polarity indicators **511** and **521** correspond to the first and second female polarity indicators **111** and **121**, indicating the maintenance of proper polarity across the electrical connector **1000**. The correspondence between the sets of polarity indicators **111**, **121**, **511**, and **521**, may provide a visual indication of the correct coupling of the male and female members **500** and **100**. As seen in FIG. **8**B, the first and second male polarity indicators **511** and **521** may not be visible from a top oriented viewing plane when the male member **500** is incorrectly assembled to the female member **100**. In addition, as indicated by the arrows for the first and second male polarity indicators **511** and **521** (the polarity indicators themselves are not visible in this view), the polarities on each side of the incorrectly assembled electrical connector **1000** have been reversed.

Referring to FIGS. **9**A and **9**B, FIG. **9**A illustrates a cross-sectional view of the correctly assembled electrical connector **1000** of FIG. **8**A as viewed along line **9**A-**9**A, while FIG. **9**B illustrates a cross-sectional view of the incorrectly assembled

electrical connector **1000** of FIG. **8**B as viewed along line **9**B-**9**B. FIG. **9**A shows an electrical connector **1000** in which a first male terminal cover **516** is inserted into a first orifice **116** and a contact surface **614** of the male terminal **600** is abutting a contact surface **214** of the female terminal **200**. The first male terminal cover **516** and the first orifice **116** may each have an approximate width of W**1** with the first male terminal cover **516** configured to fit within the first orifice **116**. The second male terminal cover **526** is inserted into a second orifice **126** such that a contact surface **614** of the corresponding male terminal **600** is abutting a contact surface **214** of the corresponding female terminal **200**. The second male terminal cover **526** and the second orifice **126** may each have an approximate width of W**2** with the second male terminal cover **526** configured to fit within the second orifice **126**. The width W**1** may be smaller than the width W**2**. This difference in widths may provide another method of inhibiting or preventing cross-polarization during connection of the male member **500** to the female member **100** (FIG. **8**A), since the male member **500** may be connected to the female member **100** when the male member **500** is properly oriented with respect to the female member **100**. The proper orientation of the male and female members **500** and **100** may provide for the correct polarity of the connection.

FIG. **9**B shows an electrical connector **1000** in which a male member **500** is incorrectly connected to a female member **100**. This type of connection may be substantially prevented by the interference between the width of the second male terminal cover **526** (W**2**) and the width of the first orifice **116** (W**1**)(e.g., W**2**−W**1**). However, if the male member **500** is somehow coupled to the female member **100** in spite of this interference, cross-polarization of the electrical connector **1000** may still be prevented by the first and second male terminal covers **516** and **526** separating the male and female terminals **600** and **200**. The first and second male terminal covers **516** and **526** may prevent contact between corresponding male and female terminals **600** and **200** when the male member **500** is in a second orientation with respect to the female member **100**. Therefore, as seen in this illustrative embodiment, cross-polarization of the electrical connector **1000** may be prevented and/or inhibited by at least two separate and independent methods, in addition to the visual indication given by the first and second male and female polarity indicators, **111**, **121**, **511**, and **521**.

Referring now to FIG. **10**, this figure illustrates an orthogonal cross-sectional view of a correctly assembled male member **500** and female member **100**. In this figure, the first and second male terminal extensions **510** and **520** (FIG. **6**A) have been inserted into the first and second female terminal chambers **110** and **120** (FIG. **3**A), or more specifically, the male terminal housing **506** portions of the first and second male terminal extensions **510** and **520** have been inserted into the first and second orifices **116** and **126** of the first and second female terminal chambers **110** and **120**. As the male member **500** is connected to the female member **100**, the resilient members **300** may initially contact the slanted portion **570** of the corresponding first and second male terminal covers **516** and **526**. The resilient contact portions **320** may respectively slidingly engage a top surface of each of the first and second male terminal covers **516** and **526**. The resilient contact portions **320** may be compressed, causing the housing interface **324** portion of the resilient member **300** to slidingly engage an interior surface of the respective first and second female terminal chambers **110** and **120**. The male member **500** may continue to be inserted into the female member **100** until the resilient contact portion **320** engages a corresponding connector retention feature **507** of the respective first and second male terminal covers **516** and **526**. At this point, the male member **500** may be securely coupled to the female member **100**. Although only one side portion of the electrical connector **1000** is described in detail, the other side portion may be similar due to the symmetry of the connector. However, complete symmetry is not a limitation required of an embodiment of the present invention and differences beyond the widths of the first and second male terminal covers **516** and **526** and corresponding first and second orifices **116** and **126** may exist.

## Another Embodiment

Referring now to FIG. **11**, this figure shows an orthogonal top view with a cross-section taken through the side of an embodiment of an electrical connector. In this figure, reference number **2000** generally refers to another illustrative embodiment of an electrical connector **2000** constructed according to aspects of the present invention. One difference between the electrical connector **2000** and the previously described electrical connector **1000** (FIG. **1**) may be the replacement of one or more resilient members **300** (FIG. **2**) of the previous illustrative embodiment with one or more resilient members **2300**. Otherwise, the function and materials for the two electrical connectors **1000** and **2000** may be considered to be the same. Similar components may be identified with similar reference numerals used in the previous description, and a detailed explanation of these components may not be repeated.

Electrical connector **2000** may comprise a female member **2100** and a male member **500**, shown here in a connected state. The female member **2100** may comprise one or more female terminals **200** (only one is visible in this view) and the male member **500** may comprise a corresponding number of male terminals **600**. When the female member **2100** and the male member **500** are coupled together, electricity may be able to flow between wire conductors (not shown) through the electrical connector **2000** via the areas of contact between the female and male terminals **200** and **600**.

The female member **2100** may comprise one or more resilient members **2300**. The resilient members **2300** may provide a pressing force to facilitate electrical conduction through the contact areas between the corresponding female and male terminals **200** and **600**. In addition, the resilient members **2300** may provide a securing force to inhibit or prevent the inadvertent disconnection of the male member **500** from the female member **2100** during the use of the electrical connector **2300** in a desired application (e.g., such as in a vibratory and dynamic environment of a remotely controlled vehicle). In some exemplary embodiments, the number of resilient members **2300** corresponds to the number of electrical connections formed or broken during the connection and disconnection of the electrical connector **2000** (e.g., two are shown in FIG. **11**). However, the number of resilient members **2300** may not be required to equal the number of electrical connections formed or broken.

Each resilient member **2300** may comprise a resilient housing **2310** integrated with the housing of the female member **2100**. As shown in FIG. **11**, the resilient housing **2310** may be substantially cylindrical for example, but embodiments of the present invention may not be limited to this geometric configuration. Each resilient member **2300** may further comprise a retention device **2324**, a resilient device **2322**, and a contact device **2320**. The retention device **2324** may comprise an Allen set screw as shown for example, or may comprise any of a number of devices able to retain the resilient device **2322** and the contact device **2320** within the resilient housing **2310**,

while in some embodiments further providing a measure of adjustability. For example, a mechanical threaded fastener, angled key, or cam device, among others, may be used. In this example, the retention device **2324** may be threadably engaged with a top portion of the resilient housing **2310**.

The resilient device **2322** may be located between the retention device **2324** and the contact device **2320**. The resilient device **2322** may be a spring, such as a coil spring, or resilient material, such as foam, among other devices. The resilient device **2322** may press against the contact device **2320**, facilitating movement of the contact device **2320** as the male member **500** and the female member **2100** are coupled together. The force applied to the contact device **2320** and consequently to the male and female terminals **200** and **600**, may be adjusted by tightening or loosening the retention device **2324**, in addition to altering the spring stiffness or material, among other methods. In some embodiments, the male member **500** may be securely coupled to the female member **2100** by tightening the retention device **2324** so as to eliminate or reduce the ability of the contact device **2320** to move within the resilient housing **2310**, thereby forcefully engaging the contact device **2320** with a connector retention feature **507**.

The contact device **2320** may be spherical ball for example, such as in a ball and spring type of mechanism. However, in other embodiments the contact device **2320** may be any member capable of moving across the surface of the first and second male terminal covers **516** and **526** (only the first male terminal cover **516** is visible in this view), such as a rounded pin, angled member, cylinder, among others. The contact device **2320** may be retained within the resilient housing **2310** between a protruding edge **2312** at one end and the retention device **2324** at the other end. During connection of the male member **500** and the female member **2100**, the contact device **2320** may engage the connector retention feature **507** as the male member **500** is fully coupled with the female member **2100**. The contact device **2320** and the connector retention feature **507** may be configured to have corresponding or interfacing features, such that when the male member **500** is fully coupled with the female member **2100**, a sensory indication of the application device **2320** engaging the connector retention feature **507** may be provided. The sensory indication may be visual, audible, tactile, or a combination of one or more of these sensory indications, in addition to other methods.

## Another Embodiment

Referring now to FIG. **12**, this figure shows an orthogonal top view with a cross-section taken through the side of an embodiment of an electrical connector. In this figure, reference number **3000** generally refers to another illustrative embodiment of an electrical connector **3000** constructed according to aspects of the present invention. One difference between the electrical connector **3000** and the previously described electrical connectors may be the replacement of one or more resilient members **300** (FIG. **2**) or **2300** (FIG. **11**) of the previous illustrative embodiments, with one or more resilient members **3300**. Otherwise, the function and materials for the electrical connectors **1000**, **2000**, and **3000** may be considered to be the same. Similar components may be identified with similar reference numerals used in the previous description, and a detailed explanation of these components may not be repeated.

Electrical connector **3000** may comprise a female member **3100** and a male member **500**, shown here in a connected state. The female member **3100** may comprise one or more female terminals **200** (only one is visible in this view) and the male member **500** may comprise a corresponding number of male terminals **600**. When the female member **3100** and the male member **500** are coupled together, electricity may be able to flow between wire conductors (not shown) through the electrical connector **3000** via the contact areas between the female and male terminals **200** and **600**.

The female member **3100** may comprise one or more resilient members **3300**. The resilient members **3300** may provide a pressing force to facilitate electrical conduction through the contact area between the female terminals **200** and the male terminals **600**. In addition, the resilient members **3300** may provide a securing force to inhibit or prevent the inadvertent disconnection of the male member **500** from the female member **3100** during the use of the electrical connector **3300** in a desired application (e.g., such as in a vibratory and dynamic remotely controlled vehicle). In some exemplary embodiments, the number of resilient members **3300** corresponds to the number of electrical connections formed or broken during the connection and disconnection of the electrical connector **3000**, two electrical connections are shown in this embodiment. However, the number of resilient members **3300** may not be required to equal the number of electrical connections formed or broken.

Each resilient member **3300** may be configured to interfere with a opposing surface of a first and second male terminal cover **516** and **526** (only **516** is visible in this view) when a male member **500** is coupled to a female member **3100**. As shown in FIG. **12**, the area indicated by cross-hatching may be the area of interference between the resilient member **3300** and the top surface of the first male terminal cover **516**, although only a portion of the abutting surfaces may be configured to be interfering. The resilient member **3300** may comprise a rib interfacing with a portion of the respective top surface of the first and second male terminal covers **516** and **526**, or the resilient member **3300** may comprise the wall of the female member housing **3102**, among numerous other configurations such as those previously described for the resilient contact portion **320**. Essentially, in some embodiments the housing **3102** of the female member **3100** may function as a resilient member, allowing at least some degree of resilient deformation or movement designed to apply a force to at least a portion of an installed male member **500** (e.g., such as the first and second male terminal covers **516** and **526**, or in some embodiments, the male terminals themselves, among other configurations). Alternatively, the first and second male terminal covers **516** and **526** may function as a resilient member, allowing at least some degree of resilient deformation or movement designed to urge the male terminals **600** together with the corresponding female terminals **200**. Further, in some embodiments, both the female housing **3102** and the first and second male terminal covers **516** and **526** may experience some degree of resilient deformation, combining together to provide a force urging the male terminals **600** together with the corresponding female terminals **200**.

The resilient member **3300** may further comprise protrusions or features configured to engage with corresponding depressions or features located on the top surfaces of the first and second male terminal covers **516** and **526**, such that the male member **500** may be securely coupled to the female member **3000** upon fully connecting the male member **500** to the female member **3100**. An example of a protrusion for the resilient member **3300** may be an arcuate ridge corresponding to the connector retention feature **507** shown in FIG. **6**B. The resilient member **3300** may at least partially resiliently deform with respect to the area of interference. Alternatively, the resilient member **3300** may take advantage of at least

some degree of resilient deformation in the configuration of the female member housing **3102**.

Another Embodiment

Turning now to FIGS. **13**A and **13**B, the first figure shows a top view of an illustrative embodiment of a male member **1500** configured according to aspects of the present invention, while the second figure shows an orthogonal cross-sectional top view of the male member **1500** of FIG. **13**A as viewed along line **13**B-**13**B. One difference between the male member **1500** and the previously described male member **500** (FIG. **1**) may be the lack of first and second male terminal covers **516** and **526** (see FIGS. **6**A and **6**B) in the male member **1500**. Another difference may be the use of first and second male terminals **1600** and **1650** in male member **1500** in place of the male terminals **600** shown in male member **500** (see FIG. **2**). Otherwise, the function and materials for the male members **500** and **1500** may be considered to be substantially the same. Similar components may be identified with similar reference numerals used in previous descriptions, and a detailed explanation of these components may not be repeated.

Male member **1500** may comprise a male housing **1502** and first and second male terminal extensions **1510** and **1520**. The first male terminal extension **1510** may comprise the first male terminal **1600**, while the second male terminal extension **1520** may comprise the second male terminal **1650**. First and second male terminals **1600** and **1650** may be configured to be insertably engaged with the first and second orifices **116** and **126** of the first and second female terminal chambers **110** and **120** of a female member **100** (see FIG. **3**A). In some embodiments, some aspects of the first male terminal **1600** may be different than similar aspects of the second male terminal **1650** in order to inhibit the cross-polarizing connection of a male member **1500** and a female member **100**. In the embodiment shown, the width W**1** of the first male terminal **1600** may be smaller that the width W**2** of the second male terminal **1650**. Interference between the larger width W**2** and the first orifice **116** may inhibit the connection between a female member **100** and an improperly oriented male member **1500** (i.e., the male member **1500** may be improperly oriented with respect to the female member **100**).

The male housing **1502** may be substantially rectangular in shape and comprise a male conductor housing **504** and a male internal wall **1505** for each of the first and second male terminal extensions **1510** and **1520**. Although a substantially rectangular shape is shown for the male housing **1502**, embodiments of the present invention may not be limited to this one configuration. Any configuration capable of accommodating one or more first and second male terminals **1600** and **1650** may be used. The male housing **1502** may be manufactured from a dielectric material able to withstand the operating conditions of an intended application and provide sufficient electrical insulation between the current carrying first male terminal **1600** and second male terminal **1650** (i.e., inhibiting the occurrence of an electrical short between the first male terminal **1600** and the second male terminal **1650**).

The male internal wall **1505** of each of the first and second male terminal extensions **1510** and **1520** may function as a male terminal support. Each of the male terminal supports (i.e., male internal walls **1505**) may respectively secure and support the first and second male terminals **1600** and **1650** in the corresponding first and second male terminal extensions **1510** and **1520**. The male terminal support may comprise one or more retention members **512** (for example as represented by **512**A and **512**B) configured to retain the respective first and second male terminals **1600** and **1650** after assembly into a male member **1500**. Although a slanted ramp type of retention member **512** is shown in FIG. **13**B to facilitate an insertion type of assembly (e.g., inserting a male terminal **1600** from the right to the left in the male housing **1502** with respect to FIG. **13**B), a person of ordinary skill in the art would not be limited to just this type of retention member **512**. Pins, rivets, fasteners, other mechanical attachments, welding, and chemical adhesives, among other various methods may be used to secure the first and second male terminals **1600** and **1650** within the male housing **1502**. Additionally, the first and second male terminals **1600** and **1650** may be core molded along with the male housing **1502** at the time of manufacture.

The first and second male terminals **1600** and **1650** may comprise retention members **612** (for example as represented by **612**A and **612**B, however, only the retention members **612** of the first male terminal **1600** may be seen in FIG. **13**B, the second male terminal **1650** may be similarly configured) corresponding to the retention members **512**. As with the retention member **512**, a slanted ramp type of retention member **612** is shown in FIG. **13**B to facilitate an insertion type of assembly, however, a person of ordinary skill in the art would not be limited to just this type of retention member **612**. Pins, rivets, fasteners, other mechanical attachments, welding, and chemical adhesives, among other various methods may be used to secure the first and second male terminals **1600** and **1650** within the male housing **1502**.

Having thus described embodiments of the present invention by reference to certain exemplary embodiments, it is noted that the embodiments disclosed are illustrative rather than limiting in nature. A wide range of variations, modifications, changes, and substitutions are contemplated in the foregoing disclosure. In some instances, some features of an embodiment of the present invention may be employed without a corresponding use of the other features. Many such variations and modifications may be considered desirable by those skilled in the art based upon a review of the foregoing description of the illustrative embodiments. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

We claim:

**1**. A female electrical connector comprising:

a female housing comprising an insulating material at least partially forming a first female receptacle comprising a first receptacle opening for at least partially receiving a first male connector electrode;

a first female electrode disposed at least partially within the first female receptacle, wherein the first female electrode comprises a first surface for electrically coupling with a first male connector electrode;

a first resilient member retained by the first female receptacle, wherein the first resilient member comprises a first resilient contact member configured to deform while a first male connector electrode is at least partially inserted into the first female receptacle;

wherein a first end of the first resilient member further comprises a first base member fixed relative to a first portion of the female housing when a first male connector electrode is at least partially inserted into the first female receptacle between a non-inserted and fully inserted configuration and a second end of the first resilient member is moveable within the first female receptacle upon deformation while a first male connector electrode is at least partially inserted into the first female receptacle;

wherein the first resilient member is configured to provide a biasing force to facilitate an electrical coupling of the first female electrode with only a first male connector electrode;

wherein the first resilient contact member resiliently deforms in response to interference from one or more portions of a first male connector electrode, when a first male connector electrode is at least partially inserted into the first female receptacle; and

wherein the first resilient member is retained within the female housing spaced from the first female electrode, whereby the first resilient member and the first female electrode are not in contact with one another.

**2**. The female electrical connector of claim **1**, wherein the first female electrode comprises a plate of conductive material having a planar first surface.

**3**. The female electrical connector of claim **1**, wherein the first female electrode is configured to remain fixed relative to the first base member.

**4**. The female electrical connector of claim **1**, wherein the first female electrode extends within a first plane configured to remain fixed relative to a second plane when a first male connector electrode is at least partially inserted into the first female receptacle between an unconnected configuration and a connected configuration, wherein the first base member extends within the second plane.

**5**. The female electrical connector of claim **1**, wherein the first resilient member is disposed within the first female receptacle on the same side of the first female electrode as the first surface.

**6**. The female electrical connector of claim **1**, wherein the first resilient member is retained within the female housing separately from the first female electrode, whereby a first male connector electrode is disposed between the first resilient member and the first female electrode when a first male connector electrode is inserted into the first female receptacle.

**7**. The female electrical connector of claim **1**, wherein at least a portion of the first base member is secured within the first female receptacle separately from the first female electrode such that the female housing electrically insulates the first base member from the first female electrode.

**8**. The female electrical connector of claim **1**, wherein the first base member extends from the first resilient contact member along the direction of insertion of a first male connector electrode to at least partially into the first female receptacle.

**9**. The female electrical connector of claim **1**, wherein the first female electrode abuts an inner surface of the first female receptacle along at least a portion of the surface of the first female electrode, with the inner surface of the first female receptacle disposed on the directly opposite side of the first female electrode from the side of the first female electrode comprising the first surface.

**10**. The female electrical connector of claim **1**, wherein the female housing comprises a uniform insulating material.

**11**. The female electrical connector of claim **1**, wherein the female housing comprises a single piece of material.

**12**. The female electrical connector of claim **1**, wherein deformation of the first resilient contact member in response to interference from one or more portions of a first male connector electrode, when a first male connector electrode is at least partially inserted into within the first female receptacle, causes the first resilient member to extend in a direction substantially parallel to the direction of insertion of a first male connector electrode.

**13**. The female electrical connector of claim **1**, wherein the first surface extends in a direction substantially parallel to the direction of insertion of a first male connector electrode to at least partially into the first female receptacle.

**14**. The female electrical connector of claim **1**, wherein the first resilient member is not in contact with a male connector electrode unless and until a male connector electrode is at least partially inserted into within the first female receptacle.

**15**. The female electrical connector of claim **1**, wherein the first female electrode is configured to remain fixed relative to the female housing to prevent movement away from a first male connector electrode when a first male connector electrode is at least partially inserted into the first female receptacle between a non-inserted and fully inserted configuration.

**16**. The female electrical connector of claim **15**, wherein the first female electrode further comprises one or more anchor portions extending from the first female electrode for securing the female electrode against longitudinal movement relative to the female housing in at least one direction.

**17**. The female electrical connector or claim **1**, wherein the second end of the first resilient member slides along at least a portion of the wall of the first female receptacle upon deformation.

**18**. The female electrical connector of claim **17**, wherein the second end of the first resilient member comprises a bend away from the at least a portion of the wall of the first female receptacle, with the bend facilitating sliding movement of the first resilient member along the at least a portion of the wall of the first female receptacle upon deformation.

**19**. The female electrical connector of claim **1**, wherein the first surface is planar and substantially aligned with the direction of insertion of a first male connector electrode to at least partially into the first female receptacle.

**20**. The female electrical connector of claim **19**, wherein the first surface extends to the end of the first female electrode.

**21**. The female electrical connector of claim **19**, wherein the first female electrode further comprises a first female connector portion, and wherein the first surface is substantially co-planar with the first female connector portion.

**22**. The female electrical connector of claim **1**, wherein a first male connector electrode is secured within the first female receptacle by an interference fit.

**23**. The female electrical connector of claim **22**, wherein a first male connector electrode is secured within the first female receptacle by an interference fit without substantial deformation of a surface of a first male connector electrode.

**24**. The female electrical connector of claim **22**, wherein the first resilient contact member is configured to deform while a first male connector electrode is at least partially inserted into the first female receptacle without any substantial deformation of the female housing.

**25**. The female electrical connector of claim **1**, wherein the first resilient contact member comprises an arcuate portion, and wherein the arcuate portion resiliently deforms in response to interference from one or more portions of a first male connector electrode, when a first male connector electrode is at least partially inserted into the first female receptacle.

**26**. The female electrical connector of claim **25**, wherein the portions of the first surface extending substantially along the length of the first female electrode are substantially aligned with a component of displacement of the first resilient member as the first resilient member deforms.

**27**. The female electrical connector of claim **25**, wherein the first surface is substantially normal to a component of the displacement of the first resilient member as the first resilient member deforms.

28. The female electrical connector of claim 25, wherein the first resilient member further comprises a leaf spring.

29. The female electrical connector of claim 1, further comprising:

the insulating material at least partially forming a second female receptacle comprising a second receptacle opening for at least partially receiving a second male connector electrode;

a second female electrode disposed at least partially within the second female receptacle, wherein the second female electrode comprises a second surface for electrically coupling with a second male connector electrode; and

a second resilient member retained by the second female receptacle, wherein the second resilient member comprises a second resilient contact member configured deform while a second male connector electrode is at least partially inserted into the second female receptacle.

30. The female electrical connector of claim 29, wherein at least one dimension of the first receptacle opening is larger than a corresponding dimension of the second receptacle opening.

31. The female electrical connector of claim 29, wherein the second resilient member further comprises a second base member fixed relative to a second portion of the female housing when a second male connector electrode is at least partially inserted into the second female receptacle between a non-inserted and fully inserted configuration.

32. The female electrical connector of claim 29, wherein the second resilient member is configured to provide a biasing force to facilitate an electrical coupling of the second female electrode with only a second male connector electrode.

33. A female electrical connector comprising:

a female housing comprising a single piece of insulating material at least partially forming a first female receptacle comprising a receptacle opening for at least partially receiving a first male connector electrode;

a first female electrode disposed at least partially within the first female receptacle;

a first resilient member retained by the first female receptacle, wherein the first resilient member comprises a first resilient contact member configured to provide an interference fit between the first female electrode and a first male connector electrode to secure the first female electrode and a first male connector electrode, when a first male connector electrode is at least partially inserted into the first female receptacle;

wherein a first end of the first resilient member further comprises a first base member fixed relative to a first portion of the female housing when a first male connector electrode is at least partially inserted into the first female receptacle between a non-inserted and fully inserted configuration;

wherein the first resilient contact member is configured to deform while a first male connector electrode is at least partially inserted into the first female receptacle without any substantial deformation of the female housing;

wherein the first resilient member is configured to provide a biasing force to facilitate an electrical coupling of the first female electrode with only a first male connector electrode; and

wherein the first female electrode comprises a first surface configured to make an electrical coupling with a male contact surface of a first male connector electrode; and

wherein the first female electrode abuts an inner surface of the first female receptacle along at least a portion of a surface of the first female electrode.

34. The female electrical connector of claim 33, wherein the first surface extends in a direction substantially parallel to the direction of insertion of a first male connector electrode along substantially the entire length of at least one side of the first surface.

35. The female electrical connector of claim 33, wherein the first base member extends away from the first resilient contact member substantially along the direction of insertion of a first male connector electrode.

36. The female electrical connector of claim 33, wherein the first female electrode is configured to remain fixed relative to the first base member.

37. The female electrical connector of claim 33, wherein a first male connector electrode is secured within the first female receptacle by an interference fit without substantial deformation of a surface of a first male connector electrode.

38. The female electrical connector of claim 33, wherein at least a portion of the first base member is secured within the first female receptacle separately from the first female electrode such that the female housing electrically insulates the first base member from the first female electrode.

39. The female electrical connector of claim 33, wherein the first resilient member is retained within the female housing separately from the first female electrode, whereby a first male connector electrode is disposed between the first resilient member and the first female electrode when a first male connector electrode is inserted into the first female receptacle.

40. The female electrical connector of claim 33, further comprising an insulating member at least partially interposed between the first resilient member and a surface of a first male connector electrode when a first male connector electrode is at least partially inserted into the first female receptacle.

41. The female electrical connector of claim 33, wherein deformation of the first resilient contact member in response to interference from one or more portions of a first male connector electrode, when a first male connector electrode is at least partially inserted into within the first female receptacle, causes the first resilient member to extend in a direction substantially parallel to the direction of insertion of a first male connector electrode.

42. The female electrical connector of claim 33, wherein the first surface extends in a direction substantially parallel to the direction of insertion of a first male connector electrode to at least partially into the first female receptacle.

43. The female electrical connector of claim 33, wherein the first surface is disposed along a portion of the length of the first female electrode facing towards the first resilient member.

44. The female electrical connector of claim 33, wherein the first female electrode is configured to remain in a fixed position relative to a portion of the female housing while a male electrode is inserted to within the first female receptacle and moving from between a non-inserted to a fully inserted configuration.

45. The female electrical connector of claim 33, wherein the first resilient member is retained within the female housing spaced from the first female electrode, whereby the first resilient member and the first female electrode are not in contact with one another.

46. The female electrical connector of claim 45, wherein the first resilient member is not in contact with a male connector electrode unless and until a male connector electrode is at least partially inserted into within the first female receptacle.

47. The female electrical connector of claim 33, wherein the first female electrode further comprises one or more anchor portions extending from the first female electrode for

securing the first female electrode against longitudinal movement relative to the female housing in at least one direction.

**48**. The female electrical connector of claim **47**, wherein the first female electrode is configured to remain fixed relative to the female housing to prevent movement away from a first male connector electrode when a first male connector electrode is at least partially inserted into the first female receptacle between an unconnected configuration and a connected configuration.

**49**. The female electrical connector or claim **33**, wherein a second end of the first resilient member is moveable within the first female receptacle upon deformation while a first male connector electrode is at least partially inserted into the first female receptacle.

**50**. The female electrical connector or claim **49**, wherein the second end of the first resilient member slides along at least a portion of the wall of the first female receptacle upon deformation.

**51**. The female electrical connector of claim **50**, wherein the second end of the first resilient member comprises a bend away from the at least a portion of the wall of the first female receptacle, with the bend facilitating sliding movement of the first resilient member along the at least a portion of the wall of the first female receptacle upon deformation.

**52**. The female electrical connector of claim **33**, wherein the first female electrode comprises a plate of conductive material having a planar first surface.

**53**. The female electrical connector of claim **52**, wherein the first female electrode further comprises a planar first female connector portion, and wherein the first surface is substantially co-planar with the first female connector portion.

**54**. The female electrical connector of claim **52**, wherein the first surface is planar and aligned with the direction of insertion of a first male connector electrode.

**55**. The female electrical connector of claim **54**, wherein the planar first surface extends substantially to the end of the first female electrode.

**56**. The female electrical connector of claim **33**, further comprising:

the female housing comprising an insulating material at least partially forming a second female receptacle comprising a second receptacle opening for at least partially receiving a second male connector electrode, wherein the second female receptacle is configured to receive a second male connector electrode;

a second female electrode disposed at least partially within the second female receptacle;

a second resilient member retained by the second female receptacle, wherein the second resilient member comprises a second resilient contact member configured to provide an interference fit between the second female electrode and a second male connector electrode to secure the second female electrode and a second male connector electrode, when a second male connector electrode is at least partially inserted into the second female receptacle; and

wherein the second resilient member further comprises a second base member fixed relative to a second portion of the female housing when a second male connector electrode is at least partially inserted into the second female receptacle between a non-inserted and fully inserted configuration; and

wherein the second female electrode comprises a second surface configured to make an electrical coupling with a second male contact surface of a second male connector electrode.

**57**. The female electrical connector of claim **56**, wherein at least one dimension of the first receptacle opening is larger than a corresponding dimension of the second receptacle opening.

**58**. The female electrical connector of claim **56**, wherein the second resilient contact member is configured to deform while a second male connector electrode is at least partially inserted into the second female receptacle without any substantial deformation of the female housing;

wherein the second resilient member is configured to provide a biasing force to facilitate an electrical coupling of the second female electrode with only a second male connector electrode; and

wherein the second female electrode comprises a second surface configured to make an electrical coupling with a male contact surface of a second male connector electrode, with the second surface disposed along a portion of the length of the second female electrode facing towards the second resilient member.

**59**. The female electrical connector of claim **56**, wherein the female housing comprises a uniform insulating material.

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